BODY BUILDERS INSTRUCTIONS

The Incomplete Vehicle Document (IVD) is supplied with each incomplete vehicle, and provides information that should be used by intermediate and final stage manufacturers in determining conformity to applicable Federal Motor Vehicle Safety Standards (FMVSS). The IVD also includes information which must be followed in order to ensure that Environmental Protection Agency (EPA) and California emission certification requirements and NHTSA Fuel Regulations are met.

This Body Builders Book contains information that may be used in addition to the IVD for any manufacturers making alterations to an complete/incomplete vehicle. No alteration should be made to the incomplete vehicle which either directly or indirectly results in any component, assembly or system being in nonconformance with any applicable Federal Motor Vehicle Safety Standard or Emission Regulation. Intermediate and final stage manufacturers should be familiar with all Federal Motor Vehicle Safety Standards and Emission Regulations and aware of their specific responsibilities as manufacturers.

For further assistance contact SVIE at: 1 (800) 875-4742

All notes are applicable to all models except where specifically stated otherwise.

Section 0 – General Instructions

Check for proper clearance between body members and chassis components which may in any way affect the reliability and performance of the vehicle by developing abrasion and wear points from moving parts or degradation from extreme environment or thermal exposure or may increase interior noise. Any attachments must consider chassis components for jounce and rebound motion at Maximum GVW.

Check headlamp aim and all vehicle illumination systems for proper operation when the vehicle has been completed. Re-aim headlamps when necessary. Check for proper operation of windshield washer, wipers and defroster system.

Extreme care must be taken when working on vehicles equipped with Engine Control Module (ECM), Powertrain Control Module (PCM), Transmission Control Module (TCM), Vehicle Control Module (VCM) or Anti-lock Braking System Model (ABS).

If arc-welding is employed on the chassis, precautions must be taken to protect all vehicle components, especially brake lines, fuel lines, fuel tank assembly, electrical wiring, ECM/PCM/TCM, and VCM or ABS. To avoid electronic component damage, disconnect battery (batteries); disconnect the negative cable first, followed by the positive. To reconnect cables; connect the positive first, then the negative.

All labels on the vehicle (any message applied to the vehicle or vehicle component that informs, instructs, or warns) must appear on the completed vehicle so the user can read them easily and without obstruction.

Service and service replacement parts for your add-on systems may not be available from a GM dealer. Those installing aftermarket systems should provide information as to where and how to obtain service.

When installing a Power Take-Off (PTO) with hydraulic lines, the following care should be exercised:

- Route and secure all hydraulic lines so that they are not in close proximity to any parts of the exhaust system. Keep all fittings and connections away from the exhaust system. Make sure connections and fittings cannot leak on the exhaust system.
- Exhaust system heat can damage and degrade hydraulic lines and components. Oils and hydraulic fluid coming in contact with a hot exhaust system could result in a fire.

Section 1 – Body

Accessory items such as refrigerator, hot water heater, furnace, etc., which operate on liquid propane gas should be located and protected to prevent exposure to any flame.

Body structures, interior and accessory arrangements must be designed into the vehicle to provide for proper load capacity and distribution on both axles and not to exceed any gross axle weight ratings. Lateral load equalization must also be maintained. The resultant Center of Gravity of the unladen vehicle must be within the limits tabulated in the FMVSS 105 section of the Incomplete Vehicle Document.

Body insulation provided by General Motors should not be removed. This includes any thermal or underbody heat shields. This insulation is provided to protect the vehicle body and occupants from excessive heat and/or provide noise attenuation. Any replacement material internal to the occupant compartment must be certified for MVSS standard on flammability. Areas of specific concern, but not limited to are:

- Underbody exhaust, muffler and tailpipe shields and insulators.
- Rear load floor interior insulation.
- Front floor interior insulation.
- Dash mat insulation.
- Engine cowl insulation - interior and exterior.
- Engine cover insulation.

Temporary Shipping Supports

Reference general arrangement for identification and location of temporary shipping supports

Support-Front Floor Panel is located at front of chassis and holds the Panel Asm-Floor and Dash vertical. This support ***must*** be removed.

Support Asm-Floor and Dash Panel Rear is located at the rear and holds the Panel Asm-Floor and Dash vertical.

Temporary shipping support should be removed from chassis after body installation. If the body builders choose to leave them on the chassis, GM is not responsible for any body durability problems that may result. The front support ***must*** be removed.

Body Attachment to Panel Asm-Floor and Dash (Driver's Island)

Bodies must be securely fastened (welded/bolted) to the perimeter of the basic vehicle structure.

It is imperative that the body assembly structure be integrated into the Panel Asm-Floor and Dash to ensure vehicle structural integrity.

Extension Asm-Floor Front Panel may/may not be required by body builder. Each body builder must determine usage for their application.

It is recommended for driver comfort a left hand foot rest into body structure (ref. general arrangement drawing for location).

Steering Column and Support

Body structure must be provided to firmly support the steering column support assembly in the fore and aft direction and laterally to minimize noise and vibration effects.

In addition, the steering column, if not properly supported during body structure assembly, may cause the steering wheel to become mis-aligned. It is the responsibility of the Body Builder to check for wheel alignment and it must be adjusted to the proper orientation (See truck service manual for wheel alignment procedures). See similar note in Section 3 – ***Front Suspension***.

To reduce the perceived levels of vehicle noise and vibration the steering column mounting resonant frequencies are to a large extent determined by the vehicle body structure and must be addressed by body builders.

The steering column has an energy absorbing characteristic that will stroke 110.0 mm. No body builder structure must interfere with the energy absorbing feature of the steering column. Areas of specific concern, but not limited to on the steering column are:

- Hazard button
- Multi-function switch
- Column tilt lever
- Upper and lower column shroud
- Ignition switch
- Steering wheel (all tilting positions)

Recommended "H" Point Seat Location

Reference general arrangement drawing for recommended seat location ("H" point) and I/P cluster location.

If this design criteria is not adhered to by the body builders, GM cannot be responsible or liable for FMVSS 101 controls and display.

The body builder is responsible for mounting the dash mounted Automatic Transmission Shift Control in a location that meets FMVSS 101.

Conversions

Added bodies must be securely fastened to the basic vehicle structure. Do not attach through side rails, but bolt securely through rail flange at floor and added reinforcing plates. A minimum of 10° departure angle should be maintained if frame and/or body is extended.

The following statement applies to P 30012 model only.

The front crossmember extension must not be used as a bumper. Body builder's bumper should be attached to the front crossmember directly opposite the side rails and to the front crossmember outboard of the side rails as required. ABS module protector extension must be maintained or replaced by equivalent part.

Air Conditioning

For additional information refer to ***Engine - Section 6***.

CAUTION: Air conditioning systems using R-134A refrigerant are equipped with metric fittings to prevent interchange with R-12 refrigerant components. Do not interchange R-134A components, refrigerant oil or service equipment with R-12 components, refrigerant oil or service equipment.

Section 2 – Frame

Hole drilling, welding, modifications, or alterations to the frame assembly are the responsibility of persons performing these operations. These same individuals assume complete responsibility for frame assembly reliability, performance after alterations and compliance to applicable FMVSS requirements.

The following procedures and specific precautionary instructions are recommended for proper installation of special bodies and/or equipment on GM frames. Failure to follow these recommendations could result in serious damage to the basic vehicle.

Flanges

Do not drill holes in frame flanges:

- Within 20 mm (0.75 in.) of radius tangent and 25 mm (1.0 in.) of raw edge.
- Larger than 12 mm (0.50 in.).
- Closer to each other than twice the hole diameter.

Holes

Holes to mount brackets, supports, and out-riggers must be drilled in the vertical side rail web with the following restrictions:

- Material between edge of hole and inside of upper or lower flange must not be less than 37 mm (1.50 in.) for low carbon steel (36,000 PSI yield).
- The minimum edge distance between any two (2) holes must be larger than twice the diameter of the larger hole.
- No holes should exceed 20 mm (0.75 in.) in diameter.
- All holes should be drilled in the frame using appropriate drilling practice and safety precautions.

Welding

CAUTION: Fuel tank and fuel lines must be drained and all vapors purged to ensure non-combustible mixture before any welding, brazing or soldering.

When welding low carbon steel side rails, crossmembers and brackets (32,000 or 36,000 PSI yield strength), emphasis is placed upon weld application techniques to avoid stress risers that may adversely affect frame operating stresses.

When welding is performed anywhere on the vehicle, precautionary measures should be taken to prevent damage to electrical system wiring or components. Prior to any welding, parts or components which could be damaged by excessive temperatures must be removed or adequately shielded; the battery cables should be disconnected at the battery. Also prior to welding, the area to be welded and surrounding area must be cleaned of all frame protective coating. After welding, when parts are cool, carefully inspect wiring and electrical components for shorts or other damage which could draw excessive currents and possibly cause an electrical system short when the battery is reconnected. Apply protective coating to areas where coating was removed.

Alterations

If the wheelbase is modified the alterer must take responsibility for compliance with affected motor vehicle safety standards and for warranty on items such as driveshafts, universal joints, center bearings and rear transmission tailshaft, transmission case fractures, output shaft bushings, bearings, brakes, fuel systems and any other related component failures. Wheel base modifications can affect the operation of the ABS system and may alter vehicle braking stability and or compliance with FMVSS 105. Additionally, the customer must be alerted in the modifier's owners manual that parts for the reworked area are not available through the General Motors service parts system.

Shear Plate Attachments

Attachments of shear plates should be accomplished by using existing manufacturing holes already available in the frame side rails. Manufacturing holes, normally 16 mm in diameter, are consistently placed along the frame side member in the center of the web on each frame.

When additional holes are required for shear plate attachment, they should be no larger than 20 mm (0.75 in.) in diameter. Holes are to be drilled no closer than 63.5 mm (2.5 in.) apart. For holes drilled forward of the rear axle, centers are to be no closer than 63.5 mm (2.5 in.) from the top or bottom flanges and no closer than 89 mm (3.5 in.) from any suspension attachments. For frame holes drilled rearward of the rear axle, hole centers are to be no closer than 51 mm (2.0 in.) from the top or bottom flange and no closer than 89 mm (3.5 in.) from suspension attachments.

No additional holes or notching of either top or bottom frame flanges is allowed.

Body tie-down holes should only be drilled in top flange no larger than 0.76 in diameter; centerline of holes should be 1.0 to 1.12 in. from the web side of the frame rail. Minimum distance between edges of the holes should be approximately 2.0 in.

Trailer Towing

The Incomplete Vehicle Document also specifies that the CG location be within certain limits for proper brake balance, and may be more restrictive than the data mentioned above. The Body Builder must use all appropriate data.

NOTE: Failure to keep body and payload CG at least 26 inches forward of centerline of rear axle will result in degradation of trailer towing capacity. Consult with your Body Builder/Final Stage Manufacturer to determine maximum tongue load for your vehicle.

Section 3 – Front Suspension

See chassis data information for clearances and assistance in calculating trim heights.

Clearance should be provided for the tire used while in full jounce (upward travel) against metal stops and at full left-hand and right-hand turn. The envelopes will be provided upon request. See ***Section 5 - Brakes.***

Allowance for the tire chain clearance shown on a maximum grown tire must allow for (1.66 in.) clearance to the sides of the tire and (2.5 in.) to the top of the tire. Be sure sufficient clearance is provided for suspension, axle and tire and wheel in full vertical travel (up and down).

NOTE: Notification to the consumer may be required in certain states if tire chains cannot be used.

Since there is a large variation in completed vehicle front weight due to differences in body weight and equipment, the front suspension alignment (toe-in) must be checked and reset if necessary after the vehicle is completed. The suspension must be reset by the Body Builder if it is found that the setting's do not conform to the specifications as outlined in the "P" Chassis Service Manual. If toe-in reset is required, check the steering wheel alignment after reset and if needed, realign for proper orientation. On P 30012 trucks with I-beams, camber and caster is designed into the axle/suspension and cannot be adjusted.

See Truck Service Manual for complete alignment procedure, specifications under "Diagnosis and Front Alignment" section.

Section 4 – Rear Suspension

Clearance to body should be provided for the suspension, axle, driveshaft and tires under the following conditions: (1) Axle in full jounce against the metal-to-metal stop, (2) Axle at 4.5° roll with one side of axle in full jounce at the metal to metal stop and (3) Axle at design position. Allowance for the tire chain clearance shown on a maximum grown tire must allow for (1.66 in.) clearance to the sides of the tire and (2.5 in.) to the top of the tire. Be sure sufficient clearance is provided for suspension, axle and tire and wheel in full vertical travel (up and down).

NOTE: Notification to the consumer may be required in certain states if tire chains cannot be used.

Pipes, wiring, conduits and any other related components must not be placed where they cross the path of motion of the rear axle, driveshaft, axle brake pipes, hoses, spring or tires. Such crossing could result in rupture, wear-through, or separation due to normal axle motion.

See chassis data information for additional clearances and for assistance in calculating trim heights.

Section 5 – Brakes

See Truck Service Manual for brake specifications.

Due to the critical nature of brake systems, anyone making modifications or alterations must assume complete responsibility for system reliability, performance and certification to FMVSS 105 or FMVSS 121.

It is mandatory that no change be made to the brake main cylinder location, brake pedal push rod length or pedal position.

Ensure that hydraulic brake system is free of air and hydraulic leaks. Bleed brakes if required, following procedures as outlined in truck chassis service manual. Ensure that hydraulic booster system is functional and free of leaks.

Check master cylinder fluid level and fill as necessary. (Refer to Owner's Manual)

Check power steering fluid level for models equipped with hydraulic boosted brake systems. (Refer to Owner's Manual)

Added floor covering or carpeting must not restrict service or parking brake pedal travel from released position to full pedal travel.

Body Builder must provide access to brake master cylinder to enable fluid level check and the ability to add fluid as required. Clearance to master cylinder should be provided to enable easy removal of the cap and replacement if ever required. Visual access to warnings printed on master cylinder reservoir must be provided per FMVSS 105.

No body part or chassis-mounted component including wheel house shields may be located within 2.0 in. of brake hose routing and/or wheel speed sensor wire in all wheel and axle positions. All exhaust system components must also have a minimum of 2.0 in. clearance to brake hoses in closest positions. (Be sure to account for brake hose and sensor wire travel with suspension).

Body builder is to verify that the brake light switch and brake warning switch is operative. This includes both the brake system differential pressure and parking brake actuator switch. Any ABS system codes that may have been set due to the body build process must be checked and cleared prior to customer delivery.

Floorboard and toe pan position cannot be altered, as it will interfere with brake and accelerator pedal movement or cause driver discomfort. The floor may be covered with normal pad and carpeting only. No floor covering should be under the accelerator pedal area it will interfere with accelerator control movement. Carpeting must have 1" minimum clearance to the accelerator pedal and should be cut-pile only. Carpeting must be properly secured to prevent any movement.

Auxiliary Braking Systems

If add-on braking systems are installed to control either tag axle or trailer braking systems, the body builder is responsible for the integrity of the system. This may require running FMVSS certification tests. Any change to the GVWR necessitate recertification to FMVSS. Care must be taken to assure that flow rate of the brake fluid is not affected by the modification, as this could reduce the effectiveness of the ABS system. The recommendations of the auxiliary brake device manufacture should be followed in making the modifications. For most systems that require a tap-in, this should be done near the rear axle of the vehicle. This allows any proportioning of the rear brakes to be communicated to the auxiliary brakes. This tap-in should not require more than .02 cu. in. of fluid, and be capable of withstanding pressures up to 3000 psi. Auxiliary brakes must be capable of taking the proportion of the braking load for which, they were designed to provide for the overall vehicle (combination) irrespective of fade or other operating effects.

Section 6 – Engine

For additional information refer to ***Body - Section 1.***

Air conditioning and auxiliary belt-driven equipment installation recommendations:

- No alterations or additions to the accessory drive belt system will be warranted on either multiple belt systems or serpentine belt systems.
- The serpentine belt type of drive is designed as a total system, incorporating a single poly-V belt and an automatic tensioner. In this type of system, degrees of pulley wrap, belt tension, and pulley alignment are very critical factors. Modification is not recommended.

Multiple belt systems may incorporate several conventional-V belts, or a combination of conventional-V and poly-V belts. If modification to this type of system is made, the following should be considered:

- The addition of a pulley sheave forward of the production sheaves may subject the crankshaft and water pump bearings to loads beyond the desired limits.
- Generally, an added load is preferable in the first belt track closest to the engine to minimize the overhang moment effect on bearings.
- Heavy or improperly balanced pulleys may contribute to bearing failure because of load induced by their mass and/or unbalance. It is extremely important (especially on the water pump) to have well-balanced and concentric pulley sheaves in order to avoid premature bearing failure. Pulley unbalance must not exceed 0.25 oz. in., and lateral and radial runout must not exceed 0.010 in. in T.I.R.
- The fan and fan clutch that come with the vehicles are matched to the equipment and conditions encountered in normal operation. Substitution of the fan and/or fan clutch may affect cooling performance. A substitute fan may be subjected to excessive stresses and might break. Substitution is therefore not allowed.
- The incorporation of an aftermarket air conditioning system could have the following consequences:
  a. Vehicle/engine/coolant overheating in certain geographical areas that normally experience high ambient temperatures.
  b. Restrictions to engine cooling fan airflow resulting in higher fan blade stress.
  c. The cooling system was not designed for an A/C condenser to be mounted in front of the radiator core.
  d. Inadequate air conditioning performance unless system capacity is enough to cool the interior space of the completed vehicle.
- Addition or relocation of pulleys behind the arc of the fan blade travel, or changes to fan fore and aft location relative to accessory drive, may alter fan stresses, and could contribute to fan blade failure. Moving the fan and/or clutch forward is also likely to overload the water pump bearing.
- The addition of air conditioning could affect conformance to FMVSS 301-Fuel System Integrity. The added equipment, in the event of an accident, could be displaced into and possibly rupture fuel system lines, hoses filters and equipment. Care must be taken not to affect such conformance.
- The curb weight of the vehicle will be affected by the weight of the added system.

In multiple belt systems, belt tension must be measured using either a mechanical gage (such as Borroughs) or an electronic gage (G.S.E. or Beta-Tech). Each gage model is calibrated for a specific type and size of belt: E.G., 3/8 in. V, 4-rib poly-V, 6-rib poly-V, 1/2 in. V, etc. Therefore, it is necessary to follow the gage manufacturer's usage instructions to get correct readings. Refer to the appropriate shop manual for tension settings.

In some single belt serpentine systems, belt tension is determined by the automatic tensioner and its position relative to the belt. No adjustment is required.

Due to the critical nature of the accelerator system, anyone making modifications or alterations assumes complete responsibility for system reliability, performance and compliance to FMVSS 124.

Caution must be taken so that the accelerator pedal remains properly located. Guidelines for accelerator pedal locations are as follows:

- Ensure that the accelerator can freely operate from idle to wide-open throttle position and return. Make sure that the pedal will not hang up on any nearby items such as carpets, floor, screws, wiring harnesses, etc. Engine cover should have at least one inch (25 mm) clearance to side of accelerator pedal with the carpet mat installed. No floor covering should be installed under pedal area.
- Accelerator to brake pedal relationship has been designed to provide minimum driver movement and should not be altered in any way.

Gasoline engine induction and/or ignition system is certified in compliance with the Federal Vehicle Emission Standards. Any alterations to the systems or components could void compliance and render the vehicle illegal. The system includes:

- Fuel system - Sequential port fuel Injection (SPFI), central port injector (CPI) and associated tubes, hoses and pipes, air cleaner outside air hose and space heat stove and heat stove pipe, fuel pump and inlet manifold, fuel vapor canister.
- Exhaust system.
- Ignition system distributor and initial spark timing setting, spark plugs, spark plug wires.
- Crankcase ventilation system.

When a vehicle is equipped with a electronic fuel injection (EFI) engine, it has an engine control module ECM/PCM/TCM or VCM. This ECM/PCM/TCM or VCM must be maintained at a temperature below 185°F at all times. This is most essential if the vehicle is put through a paint baking process. The ECM/PCM/TCM or VCM will become inoperative if its temperature exceeds 185°F. Therefore, it is recommended that temporary insulation be placed around the ECM/PCM/TCM or VCM during the time the vehicle is in a paint oven or undergoing another high temperature process.

The following statement applies to models with remote mounted air cleaners.

The Body Builder must install the air inlet duct such that it provides cool dry air to the air cleaner. Radiator baffling must be provided to prevent recirculation of air through the radiator. The air inlet must be shielded from water and snow that may come from the road, tires and through the grille.

The air cleaner position and ducting between the air cleaner and engine should not be modified.

The following applies to P models with L21 engines.

The relationship of the air cleaner assembly to the Mass Air Flow sensor (MAF) as positioned by the air cleaner outlet cannot be altered. The MAF sensor black electronic module must remain 30° forward of vertical.

Section 7 – Transmission

Starter should operate only when gear shift lever is in neutral or park position. Re-adjust the shift linkage if necessary as outlined in the Truck Service Manual.

Models equipped with brake-transmission shift interlock (BTSI) must fully apply the regular brakes before you can shift from park when the ignition key is in the run position.

After installation of the body, vehicles with automatic transmissions should have the shift linkage checked and adjusted if necessary as outlined in the Truck Service Manual.

Section 8 – Fuel and Exhaust

Fuel Systems

Due to the critical nature of sealing the fuel system, anyone making modifications or alterations to the existing system must assume complete responsibility for the system reliability, performance and compliance to FMVSS 301.

Assembly of any fuel system components may require application of a lubricant to prevent contamination of the fuel system, only GM lubricant 9985784 may be used.

The fuel evaporative emission control equipment is certified to be compliance with the Federal and California Vehicle Emission Standards. Metal fuel lines and fuel tanks have surface coating to reduce corrosion on inside and outside surfaces to comply with useful life requirements. All fuel hoses are made of a low permeation multilayer material to comply with enhanced evaporative emission requirements. Any alterations to systems or components including materials section, could void compliance. The system includes:

- Fuel tank, fuel level sender, fuel fill and vent hoses and pipes, emission canisters, fuel feed, fuel return and vapor lines, purge control solenoids, fuel fill cap, canister vent solenoid.

For these reasons,

NO ALTERATION OF THE FUEL SYSTEM IS RECOMMENDED

Temporary Tank

The temporary fuel container must be replaced with a permanent fuel tank prior to placing the vehicle into use. The replacement tank supplier and/or body builder is responsible for certifying evaporative emissions.

The following statement applies to motorhome chassis only.

The unit is fueled during shipping (gas engines only) from a temporary fuel tank which contains the tank unit for the main tank. The temporary tank is to be removed and scrapped. Transfer the tank unit with “O” ring seal to the main tank. The fuel cap for the main tank filler neck is the same as on the temporary tank. Remove the tank unit hole cover and lock ring. Discard ***only*** the tank unit hole cover. Reinstall the seal, lock ring and the tank unit assembly.

The tank as received has a vented plug marked with a tag noting “for shipping purposes only.” This plug is to be removed and a solid steel plug, shipped in the ship lose box, must be installed in place of the plug removed.

Rear fuel tank shields (NJ9 75 gallon fuel tank) provide protection for the departure angle shown on the fuel tank arrangement drawing. Any alteration to these shields requires that an equivalent angle and depth of protection be provided by the completed vehicle.

Fuel Fill

Fuel tank filler pipe location should be so situated and constructed as to prevent gasoline vapor from emitting to vents of pilot flamed devices and to body and engine compartment air inlets.

It is recommended that when mounting the fuel filler pipe assembly and vent hose that a minimum of 3.0 in. clearance be provided to any body component to prevent contact between hoses and/or mating parts and that retention be provided to ensure routing and prevent failure due to wear and fatigue. Both the fill and vent hoses must be routed (and supported, if needed) such that there are no sags or kinks. There should be a minimum of 4° of downward slope in the fill and vent pipe at any location. No fuel traps are allowed. Alterations of fuel line routings could affect the ability of the completed vehicle and are, therefor, not desirable. The complete fuel system must comply with FMVSS 301.

If additional new hose is required when installing fuel tank filler neck, this hose must be suitable for use with unleaded fuels or diesel fuel respectively and must allow the vehicle to meet EPA and California Enhanced Evaporative Emissions Requirements.

To eliminate static electricity, the fuel inlet pipe assembly attached to the body must be grounded to the frame structure with the ground strap and fasteners provided in the ship loose box.

Fuel Lines

Fuel line routing precautions:

- 12 in. minimum clearance to exhaust system is required or a metal shield must be provided.
- Fuel lines should be clipped to chassis to prevent chafing. Metal clips must have rubber or plastic liners.
- Use corrosion resistant steel tubing with short sections of approved hose to connect components. Hose-to-tube connections should be clamped for diesel systems. Steel tube ends should be beaded for hose retention. Fuel supply is pressurized by an in-tank pump for fuel injection systems. Coupled hose or nylon quick-connects must be used. Clamped hose is not acceptable for fuel injection .

All engines require a fuel return system which returns excess fuel from the injection pump and injector nozzles back to fuel tanks. Care should be taken that these lines are not blocked nor their hoses pinched. The engine may run poorly or stall if these lines are restricted or blocked.

All gasoline engine vehicles are equipped with fuel evaporative emission control equipment which is certified to be in compliance with the Federal or applicable California vehicle emission standards. Alterations to fuel tank and metering unit, lines, canister or canisters, canister filters, canister purge control valves, relay switches, canister vent solenoid, fuel fill cap, engine speed controller, or other devices/systems are therefore not allowable since vehicle adherence to C.A.R.B. and Federal regulations may be affected.

Fuel Tank

For vehicles with full frames, the tank must have a minimum clearance of 2 in. top, front, rear and sides to body and other supports.

Tank may be pressurized with nitrogen (do not use air with fuel in system) to 1.25 PSI maximum to check for final line leakage or for forcing fuel through the system. Pressures greater than this amount may be detrimental and affect tank durability.

Tapping into the main fuel supply line to get fuel for a powered motor generator is not recommended since this could result in fuel starvation, vapor lock problems and running the fuel tank dry. It is not permissible to draw fuel from a fuel return line. The fuel meter assembly has a anti-syphon feature in the return line that prevents fuel from being drawn out.

The 80 gallon gasoline tank will include a fuel draw tube in the top of the tank assembly. This is provided for body builders to use for generators. The body builder should remove the pipe plug in this fitting and plumb system to the generator from this pickup point. Added auxiliary power unit must use the same fuel as the chassis engine or a separate fuel system will be required.

The use of auxiliary fuel tanks is not recommended. If an auxiliary fuel tank is added, the alterer must take responsibility for compliance with affected motor vehicle safety standards. Also, if an auxiliary fuel tank is added to a gasoline-powered vehicle, the fuel must be drawn through a pipe at the top of the tank (balance line between tanks is not permitted).

Gasoline fueled vehicles are now equipped with a fuel pump return line. If an auxiliary tank is added, the tank selector valve must include a return port which returns fuel to the tank from which the fuel is being drawn.

In gasoline engines the fuel pump is located in the fuel tank. The battery must be disconnected before starting any work on the fuel system.

In the use of dual fuel systems, the vehicle operator should strictly adhere to the manufacturer's procedures for switching from gasoline to gaseous fuel operation. Improper switching procedures may result in overheating and damage to the exhaust system and the vehicle. The gaseous fuel tank should not be mounted in an enclosed area of the vehicle, such as the passenger compartment, truck, etc., and the system should be vented to the outside of the vehicle. In addition, vehicles converted to gaseous fuels should not be stored in enclosed places such as garages. Further, General Motors cautions purchasers that the design, location and installation of any type of fuel storage system involves significant technical and engineering considerations and that these statements on gaseous fuel conversions should not be interpreted to be an approval by General Motors of any modification to the original equipment fuel system.

Conversions to gaseous fuel should be made in conformance with applicable Federal and State regulations. Removal of emission-control components, or the addition of gaseous fuel systems which could damage or reduce the longevity of those components and could also cause the mechanical and emission performance warranty to be voided.

Exhaust System

Particular care should be taken to prevent the possibility of exhaust fumes and carbon monoxide exposure to vehicle occupants in units completed by body builders. Holes and openings through the floor and all other parts of the body must be permanently and adequately sealed by the body builder to avoid exhaust intrusion into any occupant area. If it is necessary to change the exhaust outlet location, the exhaust discharge must be unobstructed and directed away from occupant areas. Alteration of the exhaust outlet or its position may increase exhaust noise and render the vehicle illegal in those areas with pass-by noise regulations. All vehicles >10,000 lbs. GVWR come under Federal noise regulations, vehicles ≤10,000 lbs. GVWR are regulated by various state and local regulations of the Environmental Protection Agency; see those regulations for rules, test procedure and noise levels permitted.

Tail pipe outlet location must be tested statically and with the vehicle in motion to ensure that exhaust gases do not penetrate side or rear windows or under body seams and holes. Auxiliary power plants should also be tested under the same conditions. Tail pipe extension(s) must extend 2.0 to 2.5 in. outboard of body side panels. Tail pipe exit ahead of rear wheels is not recommended.

Check for leaks in exhaust systems and repair as required.

Exhaust temperatures can exceed 1600°F under extreme operating conditions, with pipe surface temperatures slightly less than this. Extreme care must be used when placing body components in the proximity of the exhaust system so as not to exceed the rated temperature limits of the components. Due to variants in underbody configurations of the vehicles, we are not in a position to make recommendations on how to insulate or design components in the proximity of the exhaust system.

Each manufacturer must make temperature checks of critical areas of his vehicle and adjust his design accordingly, or provide shielding to ensure safe operation of his body components.

The same can be said for the engine compartment. Obviously there will be additional heat radiated from the engine. How much is retained in the area will depend on how well this area is ventilated in your individual designs. Here again, temperature checks of inte-

rior areas surrounding the engine should be made to determine if your insulation is adequate. This is the same engineering practice we have followed on our complete vehicles incorporating these exhaust systems.

Exhaust system materials are selected and tested to withstand the operating environment of the vehicle. Do not modify the exhaust system in any way. The tail pipes are made of aluminized 409 stainless steel or aluminized steel.

Heat shields are mounted to the underbody and/or exhaust system components (catalytic converter and muffler). Shields for the propshaft hanger bearings are also provided in some vehicles.

Section 9 – Steering

Check power steering fluid level and system operations. (Refer to Owner's Manual)

Steering wheel and horn pad must not be altered or replaced.

The following statement applies to motorhome chassis only.

Steering wheel and shaft must be located and supported as shown on the body builders drawing.

Section 10 – Tires/Wheels

Check wheel lug nuts for proper torque; specifications are provided in the Owner's Manual.

Substitution of tires of greater capacity than those offered as original equipment by vehicle manufacturer is not approved for use on original equipment wheels. Any usage of higher capacity tires must be accompanied by higher capacity wheels. However, the wheel offset and distance from centerline of rim to wheel mounting face must be the same as the replaced original equipment wheel to ensure proper wheel bearing loading and clearance of tires to body and chassis components.

Increasing tire and wheel capacity does not necessarily increase vehicle GVW ratings.

It is recommended that tire chain clearance guideline, J683 from the Society of Automotive Engineers be adhered to in designing rear wheelhouse clearance.

Check tires and inflate to recommended tire pressure according to the tire pressure information displayed on the certification/tire label provided with the vehicle before shipment of vehicle from body builder.

Any substitution of tires may affect Speedometer/Odometer accuracy and the proper functioning of the Engine Control Module

Section 12 – Electrical

The vehicle battery should be located and positioned to make use of the existing battery cables. If the battery requires relocation and longer cables are required, a proportionately larger gauge wire must be used. If in relocating the battery the negative ground cable is attached to frame rail, a cable of similar gauge be provided between the frame rail and the engine. This is required due to the heavy electrical loads imposed by the starting circuit. To ensure proper operation of the battery cables the following chart on length, gauge and materials must be strictly adhered to:

Combined Length of Positive and Negative	
Cable Gauge	**Cable in Inches (Copper)**
4	66
2	107
0	170

Battery Installation

The battery and cable installation, provided by the body upfitter, must comply with the following guidelines. Non-compliance may result in a failure of the vehicle electrical component system, the shutdown of the engine, loss of backup brake system, loss of ABS braking control, and the possibility of fire.

- The cables must not contact any sharp edge(s), in either the normal (stored) or slid (maintenance) position (school bus application).
- The cables must not be bent in a radius of smaller than 10 times the cable diameter. Insulation failure can occur if this happens.
- The cable must be supported by clips spaced at a distance of not more than 450 mm. In this clipping, they shall not have a free movement that will allow rubbing on any vehicle component, either fixed or moveable.
- All clips used must be of the rubber-lined type, not rubber dipped.
- Do not splice the battery cables. Cable modifications can result in vehicle starting problems and loss of other key systems.
- The cables must be clipped to the battery tray such that the cable pull loads are not transferred into the battery posts due to slide tray movement. Failure to do so can result in loose terminals, poor starting and battery failure. Battery acid leakage could result around posts not properly relieved of strain.

- The cable attachments at the battery terminal must not cause undue strain at these connections. There should be no sharp bends in the cables adjacent to the connections. The cables should be routed down from the terminals rather than horizontally from the terminals to prevent a lever action that may loosen connections. Terminal corrosion inhibitors and other coatings should not be applied to the sealed electrical contact areas. Terminal torque of the sealed terminal shall be 10/20 N·m freedom, 14/20 N·m linehaul.
- Mounting Base (Tray):
  The tray should be of substantial material (minimum 1.75 mm thick or sufficiently reinforced) to resist flexing and cracking. The tray must provide firm, continuous support of the battery and not amplify vibration levels. There must be no protrusions or projections in the tray or mountings that would damage the battery. Cantilevered mountings are not recommended and the tray should be mounted flat so as not to aggravate electrolyte spillage or lead fatigue. A rounded lip of adequate height to ensure stiffness and retention should be provided around the perimeter of the tray. With the battery mounted in a vehicle, a static force of 22kg applied to a 6.54 sq. cm. area at any corner should not move the battery any more than .25 mm.
- Freedom Battery:
  The hold-down must be able to withstand a 22G-3 millisecond shock loading and prevent the battery movement relative to the mounting base or hold-down. Torque at the battery hold-down shall be 15/20 N·m (133-177 lbs. in) at the base clamp or 2.3/4.5 N·m (20-40 lbs. in.) at the top bar. A bottom hold-down centrally located at the sides of the battery is recommended.
- Linehaul Battery:
  A tight, secure hold-down is essential. Hold-down brackets must retain the battery at a 22 G-3 millisecond shock loading. A top hold-down should be spaced a minimum of 15 mm from terminal posts to avoid possible ground paths. If a top hold-down is used, a non-corrosive, non-conductive coating is desirable.

  Location:
  The battery should be located in a well ventilated area where a temperature build-up does not occur. The location should also provide protection to the battery to prevent damage from foreign objects. The ends of the battery in the area of the vent ports should be free of obstructions so that the gasses generated during charging can be freely dissipated into the atmosphere.
- Vibration - Freedom Batteries:
  The mounting should not subject the battery to vibration levels in excess of an PSD of more than 0.8g RMS for the frequency range 8 to 200 hz in any axis when exposed to the Manufacturer's Driving Schedule. The mounted battery assembly shall not have resonant frequency lower that 50 hz.

  Vibration - Linehaul:
  Battery(s) should not be subjected to peak vibration levels in excess of 3 Gs in any axis when exposed to the manufacturer's driving schedule. Vibration frequencies of 20 to 40 hz will cause resonance of battery parts and should be avoided, particularly at levels above 1 G acceleration in horizontal directions. Vibration frequencies of 10 hz or below with accompanying high displacements may cause electrolyte (acid) expulsion from the battery and should be avoided.
- Accessibility:
  The hold-down should be convenient for tools and hands so that personal injury does not occur. There should be clearance at the insulated and grounded terminals so that wrenches can be used so that accidental grounds or shorts will not occur. Terminal polarity markings, warning labels and test hydrometer should be visible. The battery "ground" connection must be readily accessible for disconnection, as required for vehicle electrical service requirements.
- Tilt Angles:
  For normal vehicle operation (at GVW), the battery should not be tilted (0°). For installation or removal, it should not be necessary to tip or tilt the battery in excess of 40°. This is to prevent acid spillage. For short duration vehicle shipment, do not tilt the battery more than 19° from the horizontal.
- Temperature:
  The temperature of the electrolyte should not exceed 52°C. Infrequent peak temperatures to 75°C can be tolerated in soak situations only. Shielding may be required to protect the battery from a source of excessive heat.
- Battery Trays:
  Battery trays are supplied with the chassis. In the case of motor homes and diesel school busses, the trays are secured to the frame rail (for shipping only).

  For other units, the tray is supplied on the radiator support. The trays shipped on the rails may be relocated to other areas on the vehicle, keeping in mind the recommendations noted above.
- Battery Storage:
  Today's vehicles have several electronic devices which result in very small but continuous current drains on their batteries, commonly referred to as "parasitic" loads. Vehicles that are not used for an extended period of time may develop extremely discharged and/or permanently damaged batteries resulting from these parasitic loads. Discharged batteries can freeze at temperatures as high as 20°F causing permanent damage.

  To alleviate this condition, check to make sure green dot is visible, recharge as necessary, then disconnect the negative battery cable on vehicles which are not going to be in service within a 30 day period. If this is not possible, batteries should be recharged periodically (every 30-60 days) until the green dot is visible.

NOTE: The ignition switch must be off when connecting or disconnecting battery cables or hangers (jumper cables). Failure to do so may overstress or damage the ECM/PCM/TCM, VCM, ABS or other electronic components.

Modifications/add-on wiring must be carefully reviewed to ensure compatibility with the base vehicle wiring by reviewing the vehicle electrical system mechanization prints, detailed harness prints and Delphi - Packard electric division connection system design

quality guidelines. Due to the wide range of modifications that may be required for vocational needs, it is not feasible for the O.E.M. to take into account all potential revisions. For this reason, any person modifying existing vehicle wiring must assume responsibility that the revisions have not degraded the electrical system performance. Add-on electrical devices should include a Metal Oxide Varistor (MOV) to protect the vehicle's electronic modules from spikes. Any add-on wiring must be properly fused and routed to prevent cut, pinch, and chafe problems, as well as avoid exposure to excessive heat. Care must be exercised that existing vehicle interfaces do not have their current load capabilities exceeded, and that the respective control devices are not overloaded. Added wire size should be at least as large as the the wire to which it is attaching in order for fuse protection to be maintained.

A Packard electric wiring repair kit is available through Kent–Moore (GM P/N 12085264, Kent–Moore P/N J38125-4). This kit contains instructions, tools and components for making repairs to wiring harness components. This kit would also greatly assist in accomplishing necessary add-on wiring such as body marker lamps, so that system reliability/durability is maintained.

Electrical wiring components can be obtained through your authorized GM dealer. Many Packard Electric components are also available through Pioneer Standard Company (1-800-PACKARD). Pioneer may also be able to assist in making necessary wiring additions by providing custom wiring stubs or jumpers to your specifications.

Fusible Link Repair Procedure:

1. Cut damaged fusible link from wiring harness assembly splice.
2. Strip insulation from harness wire as required to splice on new fusible link.
3. Fabricate a new fusible link wire approximately 6 to 8 in. long from the same wire size as the original link. (Acceptable fusible link material will be imprinted with the wire size and the wording to identify it as fusible link. Fusible link cable is not the same as normal vehicle wiring.)
4. Terminate fusible link harness wire with a suitable compression splice clip, and solder with an electrical grade rosin core solder. Wrap splice area with tape to provide electrical insulation, as well as mechanical strain relief at the splice.
5. Strip, terminate, solder, and insulate remaining end of fusible link with appropriate termination to be compatible with the rest of the electrical system.
6. For further information, refer to the instruction manual in the wiring repair kit referenced elsewhere in this section.

Section 13 – Heating/Cooling

To provide satisfactory engine cooling and A/C performance, the following conditions must be met:

- For adequate engine cooling and air conditioning performance, we recommend a minimum of 470 square inches of grille open area, directly in front of the radiator face. If the grille open area does not align with the radiator, baffles must be used to direct the air to the radiator.

Grille design guidelines to maximize the cooling system capability:

- Grille area that extends 10 inches beyond the edge of the radiator cannot effectively be 'Baffled' to direct the air into the radiator.
- When obstructions are placed in front of the radiator, tests must be conducted to determine the effect on cooling.
- Grille openings in front of the upper half of the radiator are more effective than openings in front of the lower half.
- When grille 'Bars' are used, the narrower the better.
- Grille screens should be as open as possible.
- Avoid restrictive 'Bug Screens'.
- When baffles are used, they enhance the cooling capability at road speed, but have little effect at low vehicle speed, or at idle conditions.

Do not install any internal flow restrictors.

The 3 way or 'H' valve is not required in the heater system for port fuel injected engines.

Coolant Recovery Bottle:

- Be sure to add coolant to system after adding capacity to system (heaters).

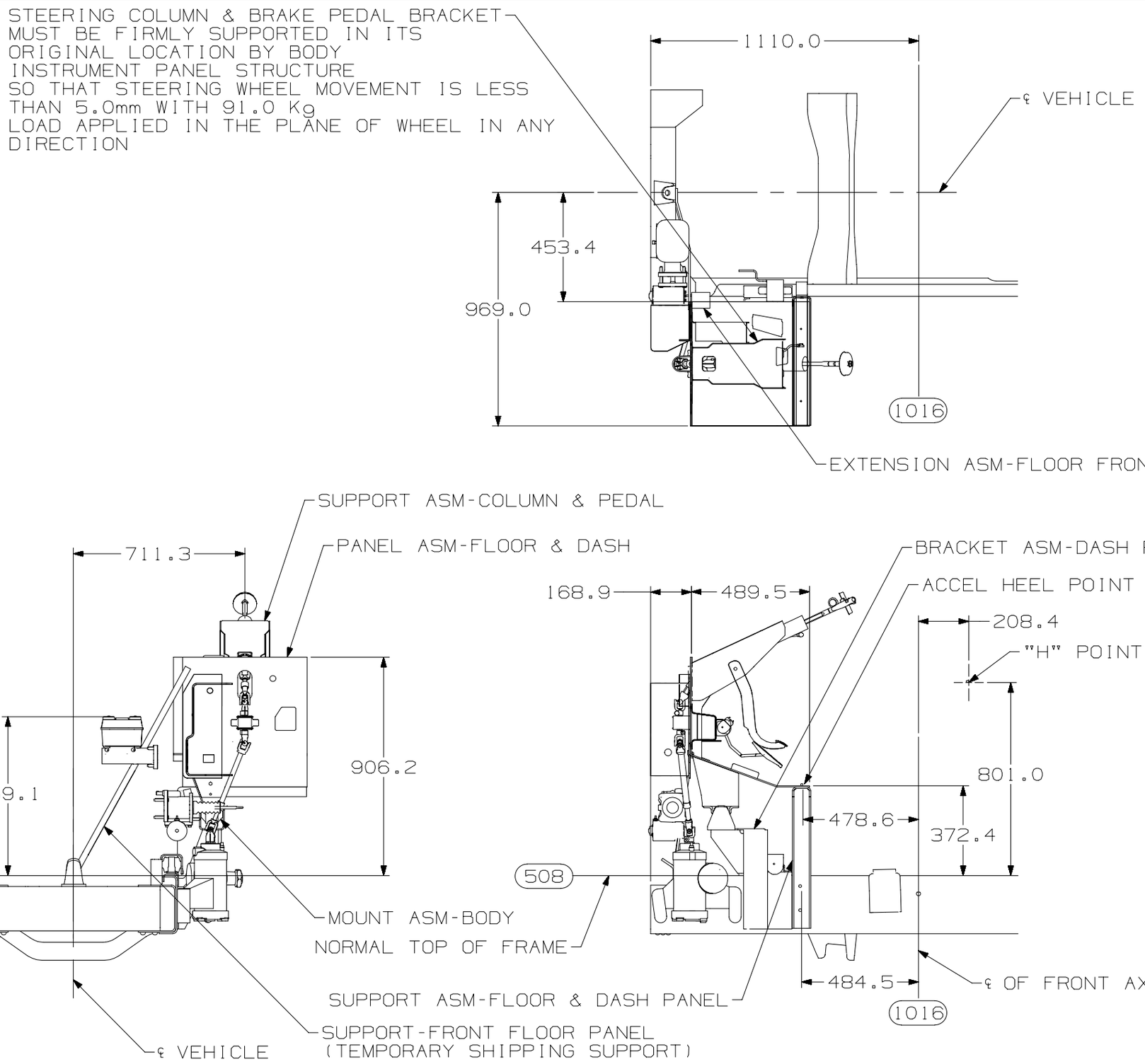
Heater

If a heater is installed on the vehicle, a bleeder valve must be added to the heater return line at the heater in the return line to the engine, valve must be at this point since it is the highest point in the system. The purpose for the bleeder is to bleed air from the system after the heater and lines are installed. Failing to do so can cause water pump seal damage.

Proper bleed procedure are as follows:

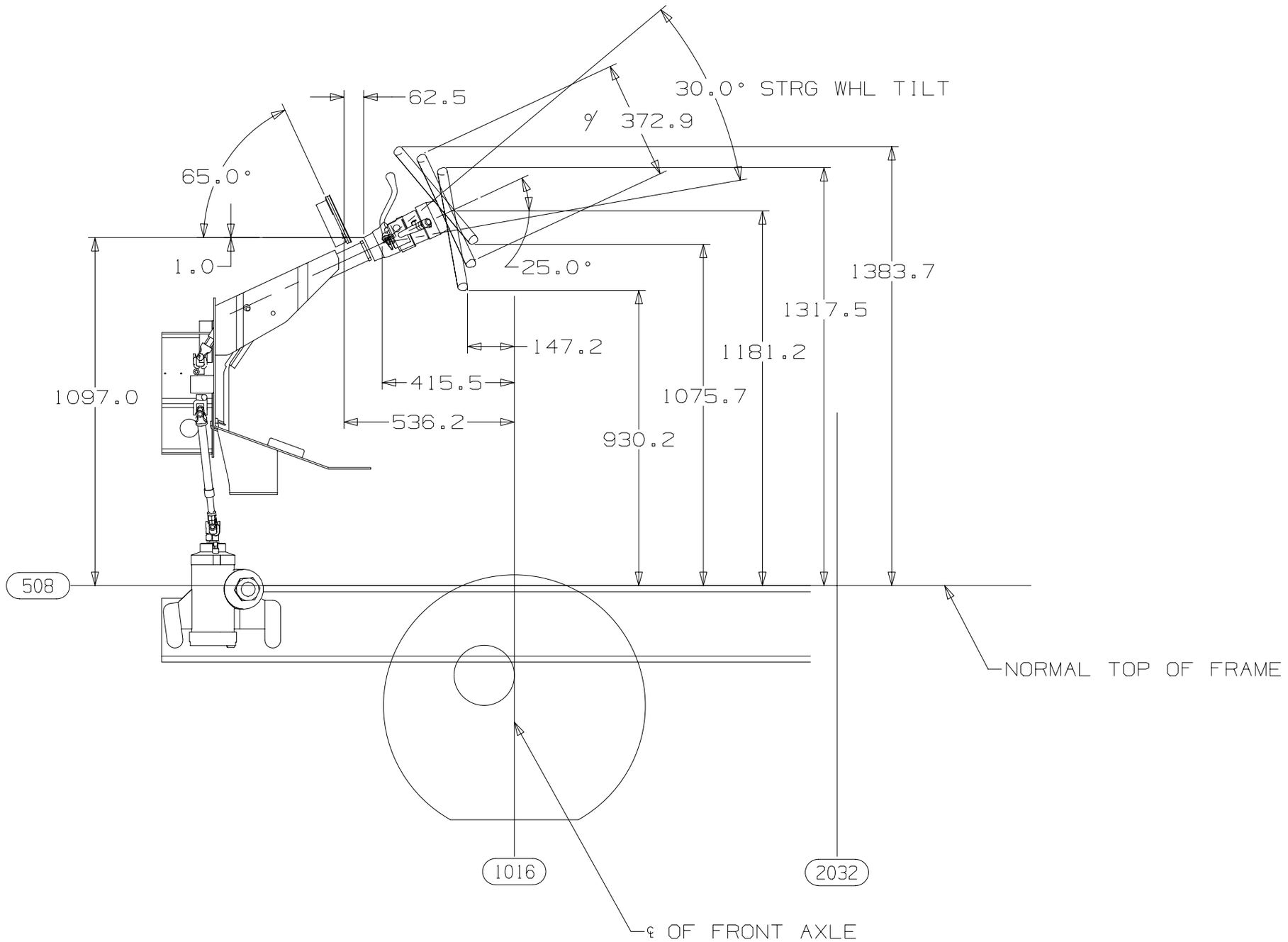
1. Open bleeder valve and fill cooling system with coolant until coolant exits valve.
2. Close valve and continue filling system until full.
3. With radiator cap off, start engine and run for approximately two minutes at medium RPM.
4. Shut engine off, open bleeder valve and fill system as above and run again for two minutes
5. Shut engine off, top off coolant and install radiator cap.
6. Check for leaks at connections.

P 32012 Drivers Island

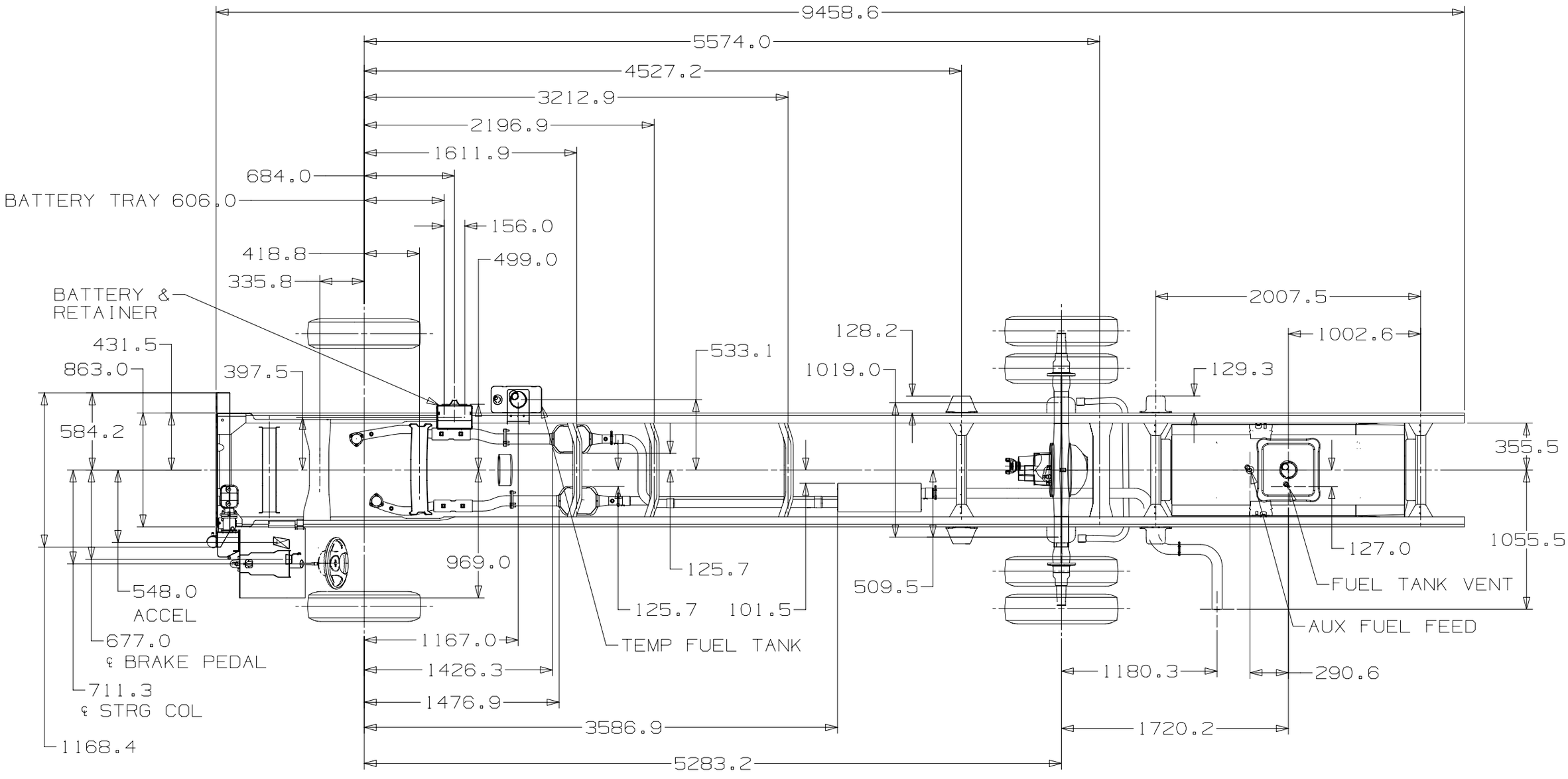


P 32012 Instrument Cluster and Steering Wheel Tilt

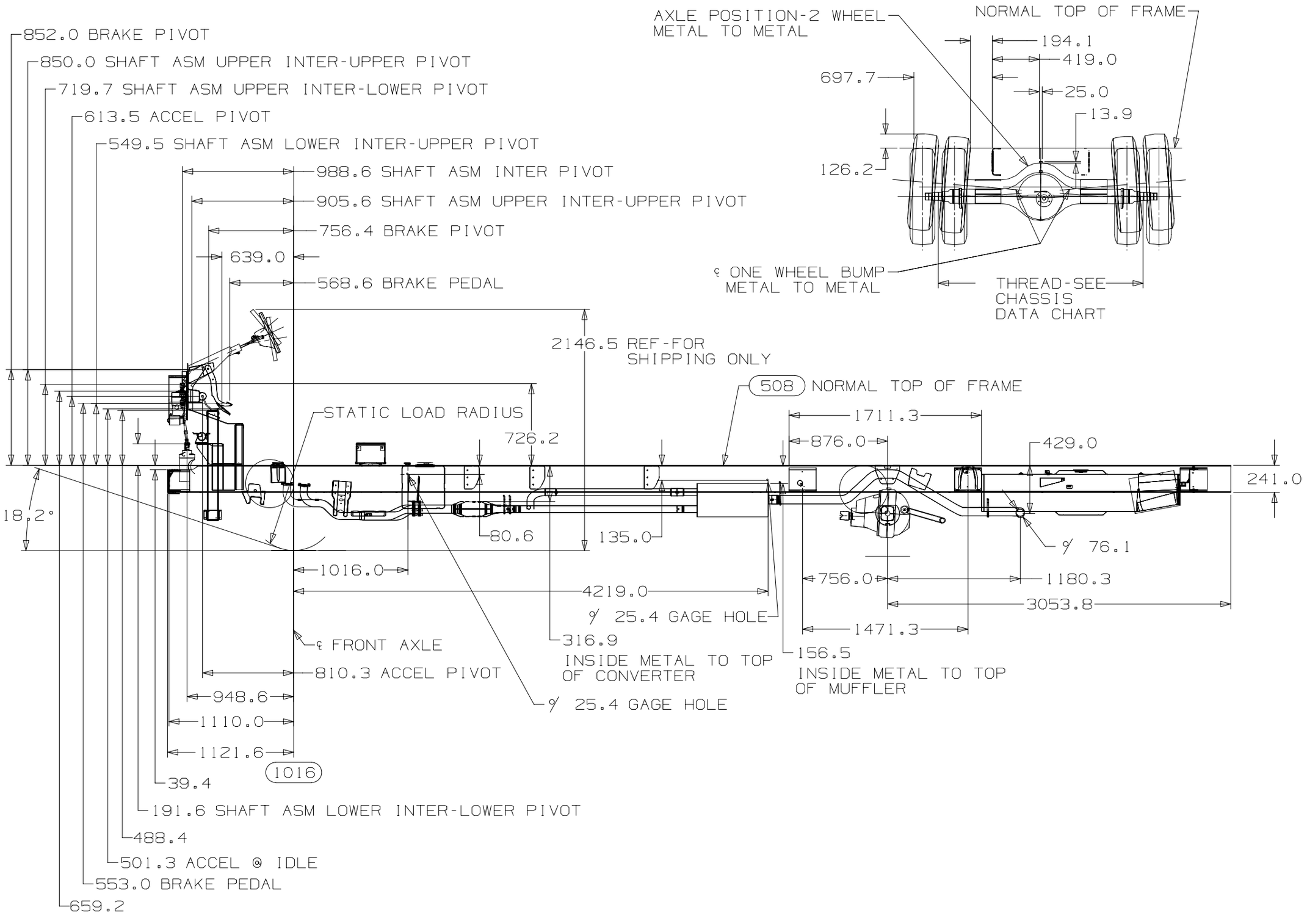
NOTE:
ALL INSTRUMENT CLUSTERS ARE
CENTERED ABOUT STEERING COLUMN



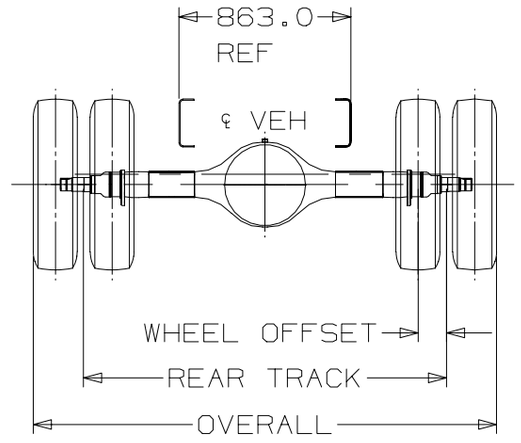
P 32012 General Arrangement



P 32012 General Arrangement



P 32012 Front and Rear Axle/Tire Data



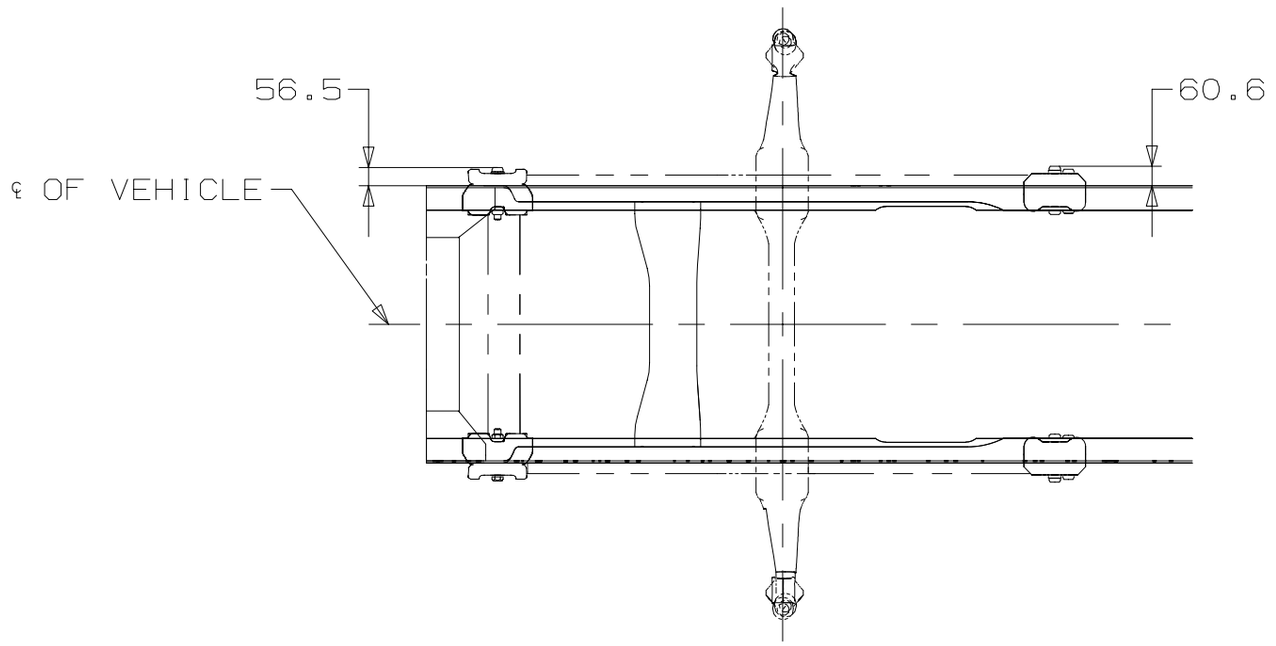
1998 P32012 GVW MINIMUN EQUIPMENT CHART

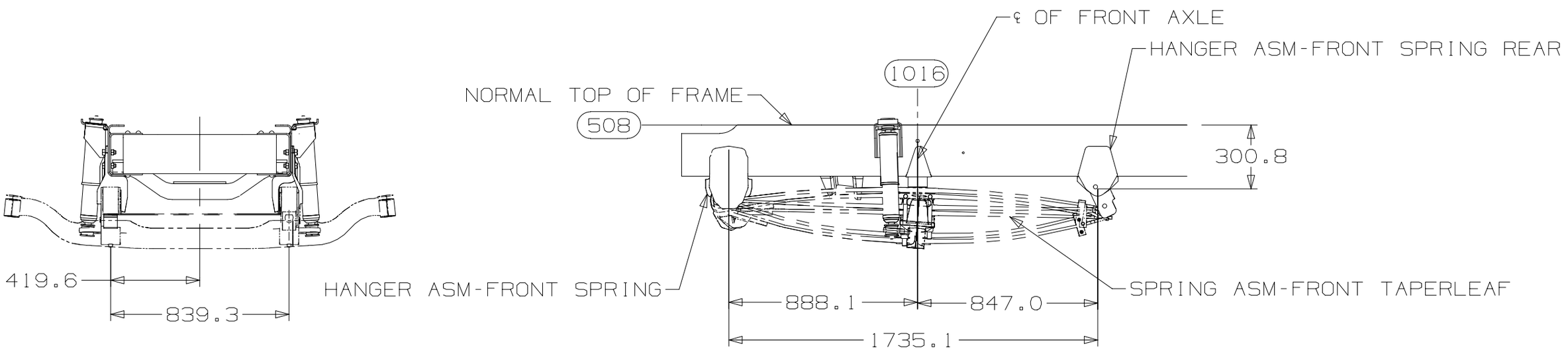
			PRSR @ GAWR	MAXIMUN FRT RTNGS				MAXIMUN RR RTNGS				OVERALL 2354.76		
MODEL	GVWR	TIRE DESC	FRT/RR	TIRE	AXLE	SPRING	GAWR	TIRE	AXLE	SPRING	GAWR	FRONT TRACK	REAR TRACK	OFFSET
P32012	21000	245/70R19.5F	100/100	8160	8100	7500	7500	15440	13500	13500	13500	2069.2	1821.3	142.24

1998 P32012 GVW OPTIONAL EQUIPMENT CHART

			PRSR @ GAWR	MAXIMUN FRT RTNGS				MAXIMUN RR RTNGS				OVERALL 2347.84		
MODEL	GVWR	TIRE DESC	FRT/RR	TIRE	AXLE	SPRING	GAWR	TIRE	AXLE	SPRING	GAWR	FRONT TRACK	REAR TRACK	OFFSET
P32012	22500	235/80R22.5G	85/85	9350	8100	8000	8000	17640	15000	14500	14500	2069.2	1821.3	144.78

P 32012 Front Suspension





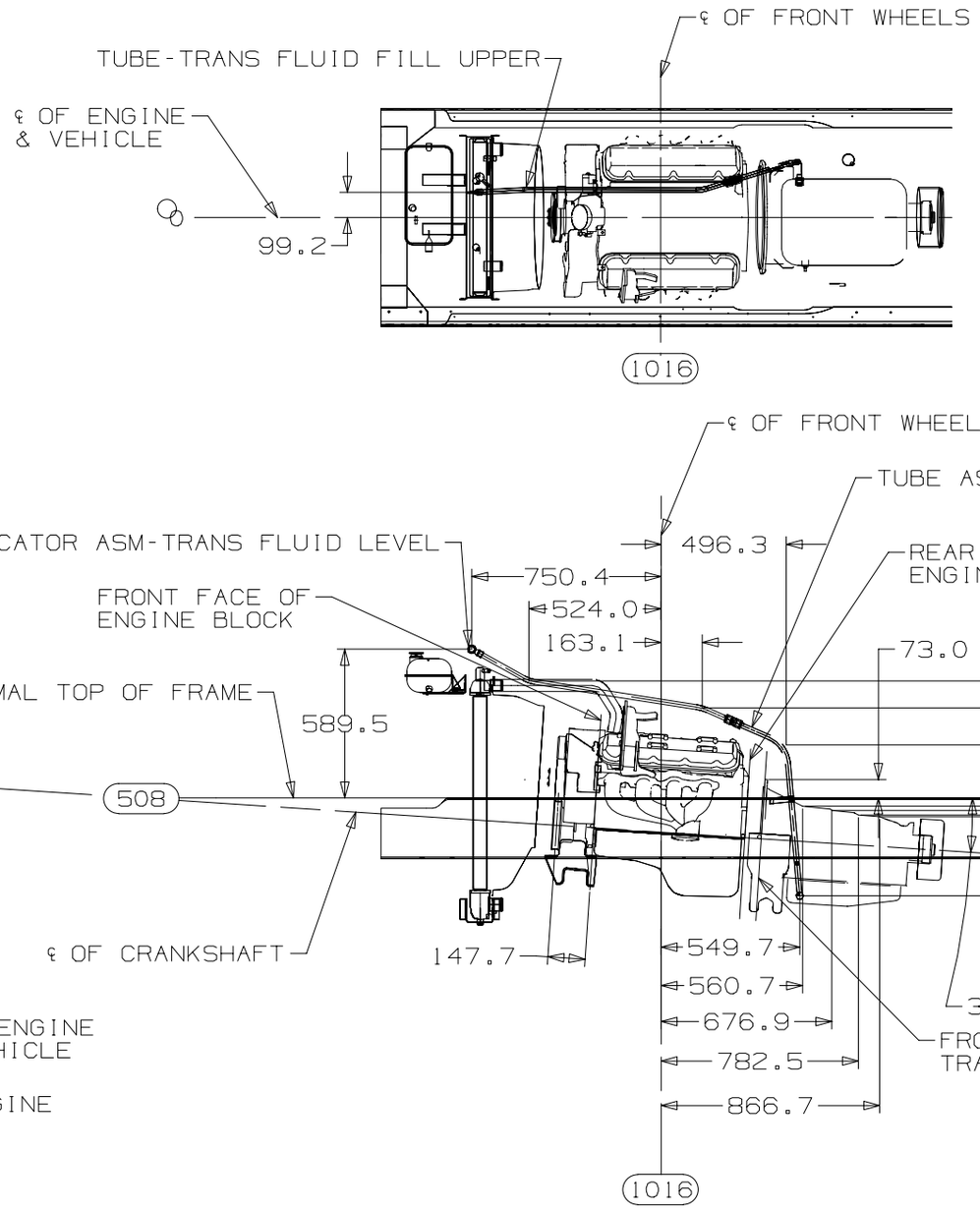
P 32012 7.4L Gas Engine, Option L21

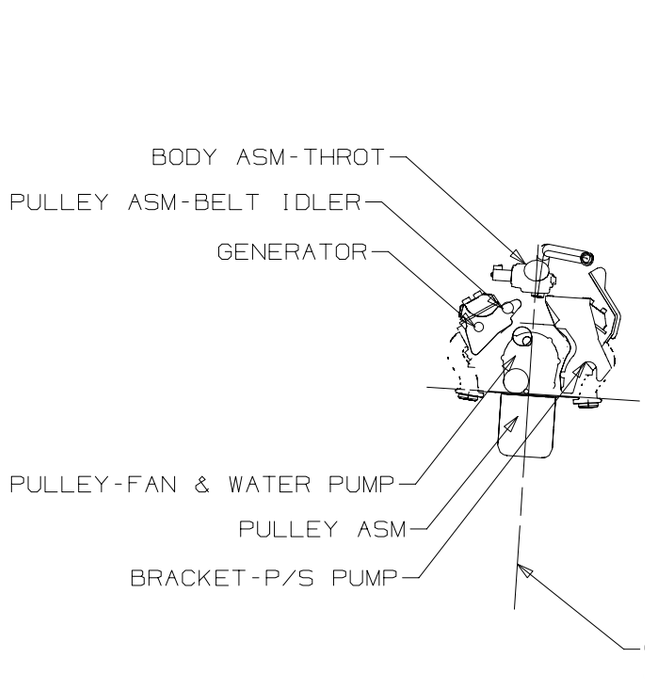
NOTES:

32.0 MINIMUM CLEARANCE REQUIRED TO ANY PART OF ENGINE FOR ENGINE ROLL

50.0 MINIMUM CLEARANCE REQUIRED IN VERTICAL MOVEMENT FOR ANY PART ON TOP AREA OF ENGINE FOR SERVICEABILITY

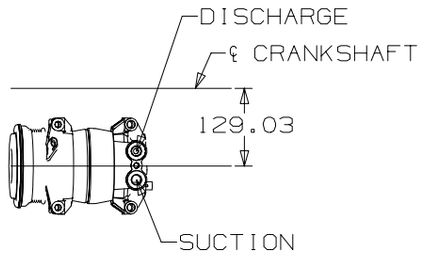
ASSEMBLY OF ANY FUEL SYSTEM COMPONENTS MAY REQUIRE APPLICATION OF A LUBRICANT,TO PREVENT POSSIBLE CONTAMINATION OF THE FUEL SYSTEM ONLY GM PART NUMBER 9985662 OR EQUIVALENT LUBRICANT MAY BE USED

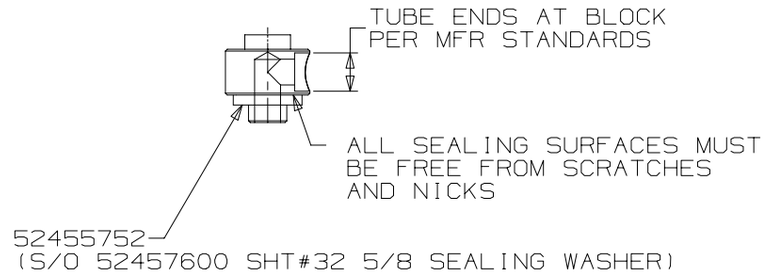




FRONT VIEW TRUE TO ENGINE

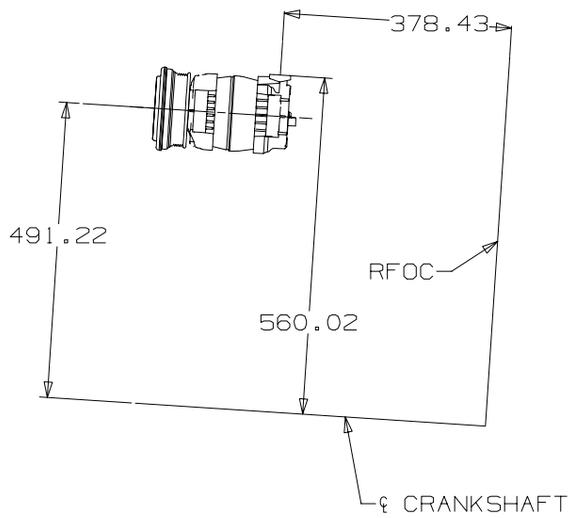
P 32012 Air Conditioning Fittings and Compressor Locations

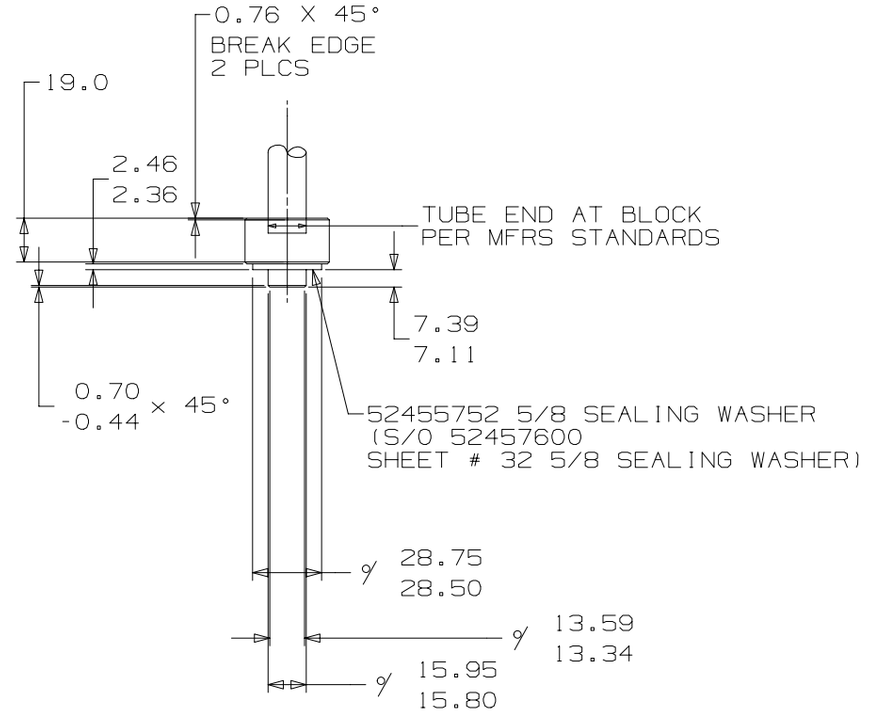




DISCHARGE FITTING
15006014.ITAC
(SUPPLIED AS PART OF DISCHARGE HOSE)

FOR USE ON A/C COMPRESSOR - HARRISION DIV.



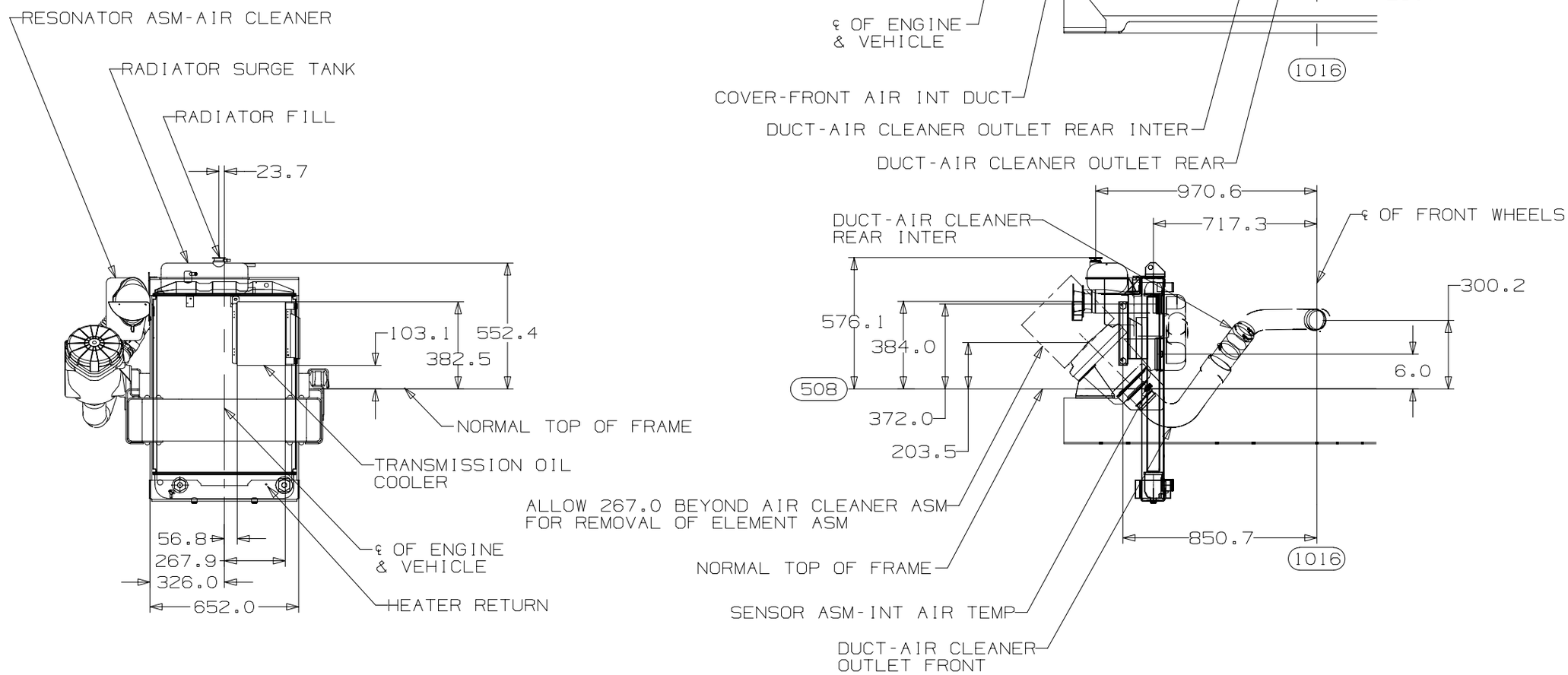


ALL SEALING SURFACES MUST BE
FREE FROM SCRATCHES AND NICKS

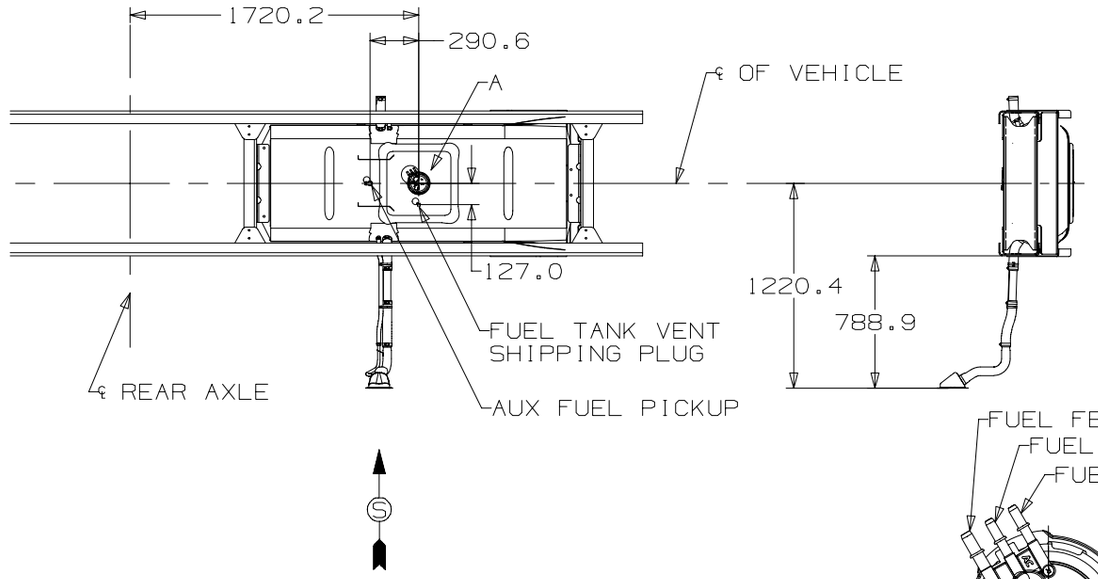
SUCTION FITTING
(SUPPLIED AS PART OF SUCTION HOSE
SUPPLIED BY BODY BUILDER)

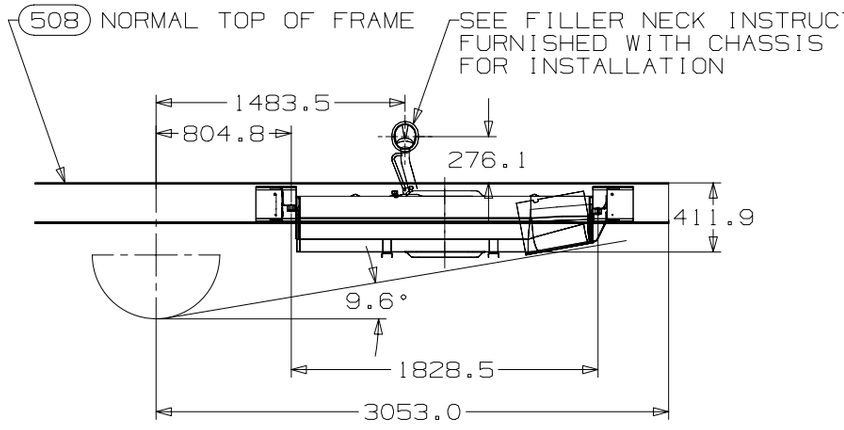
FOR USE ON A/C COMPRESSOR - HARRISON DIVISION

P 32012 Air Induction and Radiator Fill

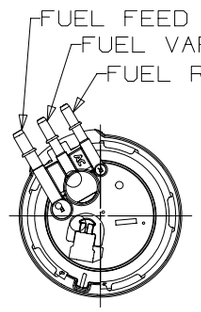


P 32012 Fuel Tank and Filler Neck Arrangement



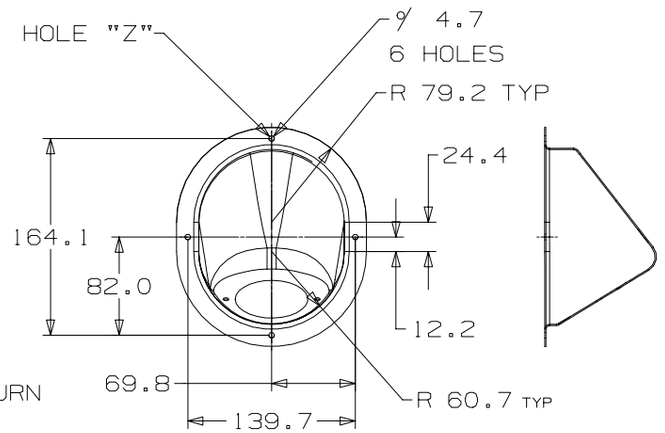


FUEL TANK REAR SHIELDS PROVIDE PROTECTION FOR THE DEPARTURE ANGLE SHOWN ABOVE, ANY ALTERATION TO THESE SHIELDS REQUIRES THAT AN EQUIVALENT ANGLE AND DEPTH OF PROTECTION BE PROVIDED BY THE COMPLETED VEHICLE



VIEW IN CIRCLE "A"

NOTE:
AFTER FILLER NECK IS ASSEMBLED TO BODY SHEET METAL FLAT PORTION OF CAM MUST BE HORIZONAL & HOLE "Z" MUST BE AT 12 O'CLOCK POSITION



VIEW IN DIRECTION OF ARROW S
FILLER NECK OPENING FOR P32012

80 GALLON FUEL TANK

REMOVE FROM THE TEMP TANK,THE SNAP RING, O-RING & FUEL SENDER.
REMOVE FROM THE PERMANENT TANK THE SNAP RING AND SHIPPING PROTECTOR
INSTALL O'RING AND SENDER ASM INTO FUEL TANK.
LINE UP TAB ON FUEL SENDER WITH SLOT IN TANK.
SECURE THE PARTS WITH SNAP RING.
REMOVE THE U-SHAPED STEEL TUBE FROM THE REAR FUEL LINES AND DISCARD PIPE.
CONNECT VAPOR LINE, FUEL FEED AND FUEL RETURN LINES TO FUEL SENDER AS SHOWN IN VIEW "A"

TANK WITH FUEL SENDER/PUMP INSTALLED IS TO BE PRESSURE CHECKED BY BODY BUILDER AT A PRESSURE NOT GREATER THAN 3 PSIG.THIS CHECK MUST OCCUR PRIOR TO REMOVAL OF PLUGS FOR VAPOR VENT OR AUXILIARY FUEL PICKUP SYSTEM

REMOVE VENT SHIPPING PLUG WITH TAG
INSTALL 15676369 STEEL PLUG
TORQUE TO 19-27 Nm

THE 80 GALLON TANK WILL BE AVAILABLE IN A CONFIGURATION THAT ALLOWS IT TO FUELED FROM EITHER THE LEFT OR THE RIGHT SIDE OF THE VEHICLE. TO ACCOMODATE THIS FEATURE, THE TANK HAS FILL AND VENT TUBES ON BOTH SIDES, THE BODY BUILDER IS TO CHOOSE WHICH SIDE HE WILL BE USING FOR FUEL FILL, AND REMOVE, AND DISCARD, ONLY THE CAPS TO BE REPLACED, BY THE FUEL FILL HOSES THAT ARE SHIPPED LOOSE. ONE SET OF CAPS SHIPPED ON THE FUEL TANK WILL REMAIN IN PLACE ON THE COMPLETED VEHICLE.

P 32012 Instrument Panel Cut-Out